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ABSTRACT

This report provides a detailed description of an education program cost model designed to accept descriptions of the size and composition of resources used in a particular program and translate them into an estimate of program cost, for convenient comparison of alternatives. The model also translates ("crosswalks") the program budget into traditional format as may be required by law. At present, many school districts create a "program budget" by reversing this process, thus losing the entire program planning aspect of PPB. The Rand model described here outputs 5-year cost estimates by (1) major program area, (2) standard budget category, and (3) program cost by budget category. The program cost output uses the approach suggested by California's Advisory Commission on School District Budgeting and Accounting, where "programs" are essentially subject areas and administrative functions. Although these definitions fall short of a true program, they are far more useful than the conventional resource categories. The computer program is not discussed. (Page 5 may reproduce poorly.) (Author)

# A PROGRAM BUDGETING COST MODEL FOR SCHOOL DISTRICT PLANNING

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## I. INTRODUCTION

Many school districts have adopted some of the *accounting* mechanics of a planning, programming and budgeting system (PPB). Although these districts produce a program budget, in the vast majority of cases the program *planning* aspect of PPB has not been a feature of the effort. The distinction between the accounting and planning aspects is important since it is the opinion of the authors that the former practice has been misrepresented as program budgeting and has, as a consequence, brought criticism to program budgeting as a tool in a school planning practice.

Because of the importance of this distinction it should be made clearer by way of example. Program budgeting calls for statements of goals and objectives, the generation of alternative ways to meet those objectives, and the analysis and selection of preferred alternatives in order to produce the most efficient program plan. The program output, the physical dimensions and the dollar cost of the programs, together, comprise the program budget. It is often necessary to translate (crosswalk) the program budget into another traditional budget form (e.g., by resource category) that may be required by law. Note that the direction of the crosswalk is from the program budget to the traditional budget. What we have noticed in many school districts, however, is what we term the "reverse crosswalk." The district does their traditional planning--how many teachers, books, etc.,--in order to produce their administrative budget. To produce the program budget, the district then reverses the procedure, multiplying some part of the administrative budget (e.g., instruction costs plus instructional support) or the total budget figure by various factors to obtain the cost of a program.

A typical procedure is to assign costs to a program in the same proportion as the classroom time spent on that program. The end product under both directions of crosswalk *appears to be the same*--costs by program. What is missing is the analysis of current practices, in terms of resources required and output, and of alternatives.

There are many hypotheses concerning why there has been a dearth of analysis-based decisionmaking in PPB. One is that the information system is not yielding the type of information needed for analysis. This data deficiency makes analysis more difficult to perform. This is certainly the case in education. School districts report expenditures by traditional budget categories that only reflect the type of resource (teachers, books, etc.) being purchased but not the program to which these resources are being directed. With the type of information that is currently being generated, it may be possible to identify programs with high effectiveness through achievement tests, but it is not possible to determine the price that has to be paid to obtain that effectiveness. If the hypothesis is correct, a logical first step to overcome the data deficiency, is the provision of a tool for aiding the determination of program cost. This paper reports on the development and construction of an education program cost model that is designed to serve as that tool in filling the data gap in program cost information.

The model is designed to take descriptions of the size and composition of resources used in a particular program and translate this information into an estimate of program cost. A program in this sense is a set of resources used in a specified manner to achieve the stated objective. For example, the quantity and price of the resources of a reading program can be entered into the model and the model will calculate the cost of the reading program. This procedure can be repeated for all programs until the complete program budget is constructed. This snapshot-in-time of the program plans of the district serves as a baseline case against which the impact of alternatives can be rapidly and consistently estimated by using the model.

Section II presents an overview of the model, covering the types of output that the planner can receive from the model as well as the inputs that can be varied to form alternative education programs. Section III illustrates the use of the model in estimating program costs. A detailed description of the model is contained in Appendix A. Appendix B presents a complete listing of the inputs to the model accompanied by the values of the inputs that are used in the base case. The operational procedures of the model itself as well as the computer program, not discussed in this paper, are available.

The model in its present form is probably too detailed for use in smaller (less than 10,000 students) school districts. Many of the features of the model such as the student flow model and the equipment inventory model would not be warranted in a district where such information can be calculated and stored without resort to computer assistance. The point here, however, is that it is not the mechanics of the model that are important, but rather the underlying procedures. A district can easily adapt the procedures of this model for its own use. More importantly, however, we hope districts will adapt the process of program costing that is incorporated into the model.

## II. OVERVIEW OF THE MODEL

The purpose of the cost model is to serve as an aid in the cost analysis of education programs. By varying the composition and price of the resource inputs, the district planner is able to simulate the cost behavior of alternative education programs.

In order to make comparisons of the cost of programs, the district planner needs a standard or base case education program. The base case represents the current cost behavior of the school district.* Alternative program inputs can then be entered into the model and the costs of the two programs compared.

The overview of the model can best be achieved by describing the inputs to the model (those things that the planner can change) and the outputs of the model (those cost items that the planner can examine). Since it is the output that partially determines which inputs are needed, the outputs of the model are described first.

### OUTPUTS

The model provides three main outputs: (1) total cost estimates by major program area, (2) total cost estimates by the standard budget category, and (3) program cost by budget category. All cost estimates are made for a 5-year period. The program cost output of this model adopts a program structure similar to that suggested by California's Advisory Commission on School District Budgeting and Accounting. In this structure, the programs are essentially subject areas and administrative functions. While these program definitions fall short of what is truly a program, they represent a more useful way of looking at the education operation than the resource input categories of the conventional district administrative budget. With this output the planner is able to gain a perspective on the composition of expenditures among programs. Figure 1 presents the output format.

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*If the model is used for state planning purposes the base case would represent a "typical" school district.

## EDUCATIONAL PROGRAM COST

| Program | Year 1 Cost | Year 1 Cost/Student | Year 2 Cost | Year 2 Cost/Student | Year 3 Cost | Year 3 Cost/Student | Year 4 Cost | Year 4 Cost/Student | Year 5 Cost | Year 5 Cost/Student |
|---|---|---|---|---|---|---|---|---|---|---|
| ELEMENTARY INSTRUCTIONAL PROGRAM | | | | | | | | | | |
| Reading | | | | | | | | | | |
| English | | | | | | | | | | |
| Mathematics | | | | | | | | | | |
| Social Science | | | | | | | | | | |
| Science | | | | | | | | | | |
| Fine Arts | | | | | | | | | | |
| Health | | | | | | | | | | |
| Physical Education | | | | | | | | | | |
| Other | | | | | | | | | | |
| HIGH SCHOOL INSTRUCTIONAL PROGRAM | | | | | | | | | | |
| Fine Arts | | | | | | | | | | |
| English | | | | | | | | | | |
| Foreign Language | | | | | | | | | | |
| Mathematics | | | | | | | | | | |
| Physical Education | | | | | | | | | | |
| Science | | | | | | | | | | |
| Industrial Arts | | | | | | | | | | |
| Driver Education | | | | | | | | | | |
| Social Science | | | | | | | | | | |
| Agriculture | | | | | | | | | | |
| Distributive Education | | | | | | | | | | |
| Office | | | | | | | | | | |
| Homemaking | | | | | | | | | | |
| Trade and Industrial | | | | | | | | | | |
| Other | | | | | | | | | | |
| INSTRUCTIONAL SUPPORT | | | | | | | | | | |
| Instructional Administration | | | | | | | | | | |
| Instructional Media | | | | | | | | | | |
| PUPIL SERVICES | | | | | | | | | | |
| Attendance and Welfare | | | | | | | | | | |
| Health | | | | | | | | | | |
| Guidance and Counseling | | | | | | | | | | |
| Food Service | | | | | | | | | | |
| Transportation | | | | | | | | | | |
| GENERAL SUPPORT | | | | | | | | | | |
| Maintenance | | | | | | | | | | |
| Operations | | | | | | | | | | |
| School Administration | | | | | | | | | | |
| District Administration | | | | | | | | | | |
| COMMUNITY SERVICES | | | | | | | | | | |

*Fig. 1--Total program cost output format*

Although building the total program plan through a program by program analysis is an essential feature of our approach, it is recognized that the resulting resource requirements must be translated into the conventional budget categories. The crosswalk between the program budget and the conventional budget is the second output of the model. This form of the output will allow the district to compare the costs of the hypothetical programs of the model with the actual costs being incurred by the school district. An example of this output feature is shown in Fig. 2.

TOTAL COST BY BUDGET CATEGORY

| | Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *1* | | *2* | | *3* | | *4* | | *5* | |
| *Budget Category* | *Cost* | *Cost/ Student* | *Cost* | *Cost/ Student* | *Cost* | *Cost/ Student* | *Cost* | *Cost/ Student* | *Cost* | *Cost/ Student* |
| 100 | | | | | | | | | | |
| 200 | | | | | | | | | | |
| 211 | | | | | | | | | | |
| 212 | | | | | | | | | | |
| 213 | | | | | | | | | | |
| 220 | | | | | | | | | | |
| 2XX | | | | | | | | | | |
| 400 | | | | | | | | | | |
| 600 | | | | | | | | | | |
| 700 | | | | | | | | | | |
| 800 | | | | | | | | | | |
| 500 | | | | | | | | | | |
| 900 | | | | | | | | | | |
| 1100 | | | | | | | | | | |
| 1200 | | | | | | | | | | |

*Fig. 2--Cost by budget category output format*

The third output option allows the planner to view the budget implications of individual programs. For each year of the planning period a matrix display of program cost by budget category is presented. The format of this display is presented in Fig. 3.

These three output options should allow the planner the needed perspective and detail for viewing the cost implications of alternative educational programs.

## INPUTS

The inputs to the model are determined by the policy choices that are to be made. Policy choices in the model are described in terms of programs, and those programs are defined in terms of their resource inputs. Therefore, the model inputs must be in the same level of detail as the policy choice and encompass those characteristics that differentiate among educational programs. Since the policy choices that the district wants to address cannot be fully anticipated, the model has been constructed to provide a great amount of flexibility, with a commensurate increase in the number of inputs. As the uses of the model are more closely defined, some of the inputs can either be eliminated from the model or set equal to a constant. It would appear premature,

however, to eliminate flexibility at an early stage of the development of an education program cost model for school district planning.

PROGRAM COST BY BUDGET CATEGORY

| | *Year t* | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Program* | *100* | *211* | *212* | *213* | *220* | *2XX* | *400* | *600* | *700* | *800* | *500* | *900* | *1100* | *1200* |
| ELEMENTARY INSTRUCTIONAL PROGRAM | | | | | | | | | | | | | | |
| Reading | | | | | | | | | | | | | | |
| English | | | | | | | | | | | | | | |
| Mathematics | | | | | | | | | | | | | | |
| Social Science | | | | | | | | | | | | | | |
| Science | | | | | | | | | | | | | | |
| Fine Arts | | | | | | | | | | | | | | |
| Health | | | | | | | | | | | | | | |
| Physical Education | | | | | | | | | | | | | | |
| Other | | | | | | | | | | | | | | |
| HIGH SCHOOL INSTRUCTIONAL PROGRAM | | | | | | | | | | | | | | |
| Fine Arts | | | | | | | | | | | | | | |
| English | | | | | | | | | | | | | | |
| Foreign Language | | | | | | | | | | | | | | |
| Mathematics | | | | | | | | | | | | | | |
| Physical Education | | | | | | | | | | | | | | |
| Science | | | | | | | | | | | | | | |
| Industrial Arts | | | | | | | | | | | | | | |
| Driver Education | | | | | | | | | | | | | | |
| Social Science | | | | | | | | | | | | | | |
| Agriculture | | | | | | | | | | | | | | |
| Distributive Education | | | | | | | | | | | | | | |
| Office | | | | | | | | | | | | | | |
| Homemaking | | | | | | | | | | | | | | |
| Trade and Industrial | | | | | | | | | | | | | | |
| Other | | | | | | | | | | | | | | |
| INSTRUCTIONAL SUPPORT | | | | | | | | | | | | | | |
| Instructional Administration | | | | | | | | | | | | | | |
| Instructional Media | | | | | | | | | | | | | | |
| PUPIL SERVICES | | | | | | | | | | | | | | |
| Attendance and Welfare | | | | | | | | | | | | | | |
| Health | | | | | | | | | | | | | | |
| Guidance and Counseling | | | | | | | | | | | | | | |
| Food Service | | | | | | | | | | | | | | |
| Transportation | | | | | | | | | | | | | | |
| GENERAL SUPPORT | | | | | | | | | | | | | | |
| Maintenance | | | | | | | | | | | | | | |
| Operations | | | | | | | | | | | | | | |
| School Administration | | | | | | | | | | | | | | |
| District Administration | | | | | | | | | | | | | | |
| COMMUNITY SERVICES | | | | | | | | | | | | | | |

*Fig. 3--Program cost by budget category output format*

The following inputs are illustrative of the type of variables that can be used in the design of the educational program.

1. *The number of students by grade and course in the first year of the planning period.* This variable allows the planner to study differences in costs due to differences in the composition of the student body. Schools of the same size may have different resource requirements

because of differing distributions of students among the various courses--i.e., college preparatory, vocational-technical. Through further research, the model can also serve as a tool in examining possible economies of scale in education. The resource implications of dividing or consolidating school districts (or parts of districts) could be examined through a further refinement of the model.

2. *Salary and wage schedules.* The salaries of teachers and specialists can be varied by subject and grade. The cost of teachers is the largest item in the school budget. Because of this importance, the model permits the examination of various salary policies for individual programs. Other personnel are assigned wage rates that vary by job classification only.

3. *Standard class size.* Increases or decreases in the standard class size can have a dramatic impact on the cost of education. The model allows the user to examine the sensitivity of the total system cost of changes in the standard class size. The standard class size is allowed to vary by grade and subject to provide the planner greater flexibility in building the education program.

4. *Paraprofessional-hours per class-hour.* One important possibility for achieving economy in education is through the substitution of paraprofessional labor for teacher labor. This technique can be used to increase the class size while allowing the teacher to spend more time on educational activities as opposed to administrative activities. The cost of different compositions of the educational team can be examined through the use of the model.

5. *Course-grade-subject probability matrix.* Students in the higher grades usually have a wide variety of subjects from which to choose. The model accounts for this multitude of choices by first defining different courses that a student can take. Examples of courses would be college preparatory and vocational-technical. The probability matrix states the probability that a student in a grade and course will take a particular subject.* The state has an influence over these

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*The program categories that are used in the model often encompass more than one subject. For example, the mathematics program includes both geometry and algebra. If a student were to enroll in both of them, his probability for mathematics must be equal to 2. Since by definition probabilities cannot exceed 1, the name "probability matrix" is not strictly correct.

probabilities through its specification of parts of the curricula. The model will allow the planner to examine the resource impact of changes in general state requirements.

6. *Student attrition by grade and course.* This variable allows the planner to examine the effect of changes in immigration, fertility, and dropout rates on the cost of the public school system. To build a student flow model, however, will take additional effort.

7. *Teacher equivalent hours per week.* By varying this input, the planner can examine the resource implications of increasing or decreasing the time that a teacher devotes to classroom instruction.

8. *Material and equipment cost factors.* Cost factors by grade and subject can be entered for material and equipment. Both material and equipment are differentiated by whether it is student or classroom related. This allows the analyst to identify the material and equipment requirements associated with different class sizes. Equipment can be inventoried so that the time pattern of equipment purchased can be more clearly identified.

There are many more variables in the model that can be changed to alter the cost of education. These variables are of rather minor importance compared to those just discussed. These other variables are discussed in the detailed description of the model contained in Appendix A. A complete list of inputs is presented in Appendix B.

## III. USE OF THE MODEL

The basic intent of the model is to aid the school district in evaluating the cost implications of alternative education programs. Directly, the model provides this aid in the form of rapid calculations. Indirectly, the model serves as a [illegible], in developing an analytical approach and as a device for organizing district data. A great deal of analysis must be performed in the preparation of the inputs and in the interpretation of the outputs. The usefulness of the model will be in direct proportion to the quality of this analysis.

The inputs to the model are not readily available from existing sources. The paucity of data stems from two sources. First, the accounting system used by school districts is not designed to yield information on the cost of individual programs. The present accounting system can easily generate the total cost of teachers, for example, but not the cost of teachers for the *reading program*. The second difficulty in obtaining data is that the structure of the education program might not correspond to the structure of the model. Because of the wide variation in the nature of education programs, it is almost impossible (and certainly not efficient) to construct a computer program that will be able to accept raw data directly from all education programs. As a simple example of this problem, the program description may list the number of instructional supervisors for each participating school, while the model estimates the number of supervisors as a percentage of the number of teachers in the program. The conversion of the raw data into a form suitable for the model is not difficult in this case. One would merely divide the number of supervisors per school by the number of teachers per school to obtain the number of supervisors per teacher. The proper transformation of the raw data may not be so simple in other cases. If this happens often enough, it is a signal that the structure of the model should be changed to reflect the cost reporting structure of the education program more accurately.

The discussion of these data problems should not degrade the importance of the model in educational planning. The usefulness of the model can be seen most clearly through a demonstration analysis. The actual educational program used for this demonstration is given the fictitious name, Preparing Readers, (PR), for the purpose of anonymity.*

PR is a program designed to individualize reading instruction for grades K-6. Various levels of attainment in reading skill are established. Instructional materials are developed to aid the student in making the transition from level to level. Pre-tests and post-tests are an integral part of the program as they establish the location and growth of the student within the hierarchy of skills.

As far as the model is concerned, the only difference between PR and any other reading program is the quantity and price of resources consumed in the program. Since many of the resource requirements of the education program under examination and that of a typical program will not be different, it is convenient to have the values of inputs for a typical or "base case" school district stored within the computer program. To estimate the cost of a particular program, then, only changes in resource requirements from the base case need be entered. In the analysis of exemplary programs, for example, only those characteristics that are different from the base case program have to be examined. The model then has the capacity to incorporate these changes with those parts of the school program that have not changed in order to estimate the total program cost.

There is, of course, some difficulty in defining the characteristice of the base case program. The base case data that are reported here (see Appendix B) were derived partly from a study of several districts in California that are implementing Planning, Programming, and Budgeting (PPB) and have estimates of their educational program costs.

*During the period of the construction of the cost model, a parallel effort was made to analyze the costs of exemplary educational programs. The data reported here on PR are a result of that effort.

Another source of base case data came from cost factors developed by members of the California State Department of Education.* As a better indication of the typical education program becomes clear through further research, the inputs should be altered to reflect this new perception of the base case.

An analysis of PR revealed several differences in cost and composition of resource requirements between it and the base case. These differences are then transformed into differences in model inputs for the model. To illustrate the type of analysis that must be performed in the preparation of the inputs, a discussion of the derivation of the input values for PR is presented below.

1. *Average salary of a reading teacher.* The average salary of a teacher in PR is $1300 lower than the average teacher salary used in the base case. A word of caution is necessary however, in the interpretation of this as cost reduction if the model were used for the purposes of planning in another district. The model estimates what it costs to operate PR. It could be concluded that a "good" reading program (assuming that PR is considered good by some objective standard) can be operated at the same expenditure level as PR. If the model were used to estimate the cost of expanding PR to another district, it would probably not be politically feasible to achieve economies through the reduction of teachers' salaries. For determining the cost implications of implementing this program, a district would use their own salary structure.

2. *Paraprofessional hours per class hour.* PR consumes 200 class hours per day. Forty-two paraprofessionals are utilized for two hours per day in the program. Therefore, the ratio of paraprofessional hours to class hours is 84/200, or .42. It should be made clear that these paraprofessionals are often not part of the classroom environment. In PR, some paraprofessionals distribute reading materials out of a central location and do not as a matter of course enter the classroom. The number of paraprofessional hours per classroom hours is an estimate of a resource requirement, but is not a descriptor of the way the program operates.

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*From a draft report by Edwin Harper, *Basic Program Support for the Public Schools*, State Department of Education, Sacramento, November 12, 1970.

3. *Reading specialist.* Each school engaged in PR is assigned a reading specialist. In the model, however, specialists are estimated as a function of the number of teacher equivalents in each subject. The number of teacher equivalents is equal to the number of teachers required for a subject assuming that the teacher taught nothing but that subject. For example, assume that there are five second grade reading classes. Under the self-contained classroom concept, five teachers devote one hour a day to the instruction of reading. If each teacher works for five hours per day, the number of teacher equivalents required by the second grade reading program would be one (five class hours per five class hours per teacher).

In the case of PR, approximately 200 teachers are involved for one period per day. Assuming that each teacher is assigned five periods of instruction per day, the number of teacher equivalents devoted to PR would be 40 (200/5). Currently there are ten reading specialists involved in the program. Therefore, the number of specialists per teacher equivalent is .25 (10/40).

4. *Textbook and materials per student.* PR personnel estimated that the cost of instructional materials per child is approximately $3.40. It is assumed that this material is in addition and not a substitute for the textbook and materials reflected in the base case inputs. This means that the new input to the model for the textbook and materials costs of PR should be $5 ($3.40 + $1.60 for regular program) per student. The accuracy of this estimate is in some doubt and illustrates other factors that should be considered in developing such an estimate. The estimate does not include the development cost of the material, and some of the resources for reproducing the material are free goods to PR. This estimate also assumes that the cost is independent of scale. Since such indpendence is not characteristic of most printing operations, applying the cost factor of $3.40 is questionable. Questionable data, however, will have to be relied on until "better" data are available. When uncertainty exists about the cost or quantity of resources used in a program, sensitivity analysis should be used to test the effect that assumptions about the variables have on the total

program cost.* Where different assumptions would have an impact on policy choice, further research on the cost of the particular resource in question is necessary.

5. *Special equipment per classroom.* PR does not have any special equipment for the classroom. It does require a central storeroom for the materials at each school, however. The cost of shelving for the materials has been estimated by PR personnel to be approximately $1000 per school. Although this resource does not appear in the classroom, its cost can be thought of as being generated by the number of classrooms involved in the program. On the average, there are approximately 20 classrooms at each school.** This would mean each classroom creates a demand for $50 worth of equipment to store and distribute classroom material.

6. *Lifetime of special equipment.* The lifetime of special equipment is much longer than the planning period of five years. The life of the equipment is set equal to six years, which means that it will never have to be replaced during the planning period.

The particular values of the inputs that are entered in the model, however, are a function of the policy question being examined. For the purposes of illustration, two questions that could be answered with the aid of the model have been selected. The first question is, "What is the correct cost of operating PR?" The answer to this question can give the planner an estimate of the cost to achieve the levels of effectiveness being reported by PR.

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*Sensitivity analysis in this case consists of examining the sensitivity of the total cost of the program to changes in the value of the model input in question. For a further discussion of sensitivity analysis, see G. H. Fisher, *Cost Considerations in Systems Analysis*, American Elsevier Publishing Company, Inc., New York, 1970.

**Alternatively, the model could be changed to allow for equipment per school. If the model is to be exercised for schools of different size, however, this can lead to distortions. Large schools, for example, may need considerably more than $1000, while small schools could possibly keep the materials right in the classroom at little additional expense. While the shape of the cost function is not clear, it does not appear unreasonable that it is linear in the number of classrooms being utilized.

The second question is, "What would the incremental cost be to implement PR in other schools or school districts?" The inputs for PR may not be applicable for estimating the costs for other districts. The main difference, of course, is that some districts pay higher prices for their resources than other districts. It would not be reasonable, for example, to estimate the cost of implementing PR in other school districts using wage and salary schedules of the districts' currently involved in the program.

In order to answer these two separate questions, we need two different sets of inputs. The inputs previously derived for PR, of course, are the ones to use in estimating the cost of PR as it is currently being operated. This set of inputs is listed under Alternative 1 in Table 1. The inputs that are needed to address the question of the incremental cost of implementing PR in other school districts are listing under Alternative 2 in Table 1. The inputs for this alternative are the same as for Alternative 1 with the exception that the salary of a reading teacher is now lowered to the PR salary schedule, but remains at the base case value ($9300 per year). The assumption in Alternative 2 is that the salary structure in other districts would not be affected by the implementation of PR.

Table 1

DIFFERENCES IN MODEL INPUTS FOR PR AND THE BASE CASE

| | *PR* | | |
|---|---|---|---|
| *Input* | *Alternative 1* | *Alternative 2* | *Base Case* |
| Average salary of a reading teacher | $8000/yr | $9300/yr | $9300/yr |
| Paraprofessional hours per classhour | .42 | .42 | .05 |
| Reading specialist per teacher equivalent | .25 | .25 | .02 |
| Textbook and materials per student | $5 | $5 | $1.60 |
| Special Equipment per classroom | $50 | $50 | 0 |
| Lifetime of special equipment | 6 yrs | 6 yrs | -- |

Table 2 presents the estimated cost per student of the reading program for both the base case and the two alterantives.* For a specified number of students, Alternative 1 is estimated to be \$14.2 per student more than the base case in the first year. Alternative 2 is approximately \$4.4 per student more expensive than Alternative 1 and \$18.6 per student more expensive than the base case reading program. This last figure of \$18.6 per student is an estimate of the incremental cost to implement PR in another district, using that district's resource prices.

Table 2

COST PER STUDENT OF READING PROGRAMS

(In \$ per yr)

| | Year | | | | |
|---|---|---|---|---|---|
| | *1* | *2* | *3* | *4* | *5* |
| Alternative 1 | 48.8 | 49.5 | 51.8 | 54.4 | 57.0 |
| Alternative 2 | 53.2 | 54.1 | 56.7 | 59.5 | 62.4 |
| Base case | 34.6 | 36.6 | 38.0 | 39.8 | 41.8 |

While this program cost information is not sufficient for making education program decisions, it is necessary. The model can put the planner in the position of knowing the price of what he is buying. Coupled with information on the effectiveness of the program, the model provides a rational planning framework for the evaluation of educational alternatives.

*These estimates are sensitive to the amount of class hours per week that is devoted to reading instruction. The base case estimates of this amount (see Appendix B) were used in this example. A further assumption of this analysis is that PR is taught in grades K-8.

## IV. EXTRA-DISTRICT PLANNING USES

Educational planning demands more and better information about the resources used, about the process by which the resources produce particular outcomes, and about the outcomes themselves. The information should include not only the specific measures of the resources used and of the outcomes achieved but also the variables, and their dimensions, that affect the process of education. This information base is needed whether the basic objective of the educational planning effort is to improve the quality of education, to achieve a more effective use of resources, to develop a better curriculum, or to reduce cost of education.

The education program cost model is designed to provide a tool for this planning effort. The development of the model recognized the existence of many efforts investigating the production function of the educational process. In the light of this recognition, the model is developed to complement these efforts. That is the model, by adding program cost data, is designed to be an integral part of on-going efforts contributing to a greater understanding of the cause-and-effect, or input-output, relationships of education.

The education program cost model complements the many efforts seeking to determine the effect of different resource inputs on educational outcome. It has been generally accepted that resources, measured commonly by dollars or cost, can be quickly calculated. That is, the number of things and their unit price equals "the cost" or input. The model was developed to make more precise and more realistic the input side of the input-output relationship.

On the input-side, identification of what might be called the non-resource variables that affect the process and, thus, the output is also necessary. Such variables include teacher characteristics, management techniques or policies, and environmental conditions of the district school, or classroom.

Briefly, the approach would be to begin with an examination of the whole of the activities of a relatively small unified school district. The purpose would be to find out not only *what* the dollars are buying but also *how much*, measured in both traditional and programmatic terms. The analysis of the school district expenditures would cover the activities falling into the broad categories of instruction, instructional support, and general support. The major emphasis, however, would be on the instructional activities. Within instruction, analysis of subjects or programs other than reading or mathematics would be stressed.

In essence, this task would be an in-depth look at what goes on in a school district. The results of this analysis should be useful in refining the resource utilization of a school district and in providing better data for the investigations, as well as in developing the data needed for the program cost model.

## V. LIMITATIONS OF THE MODEL

It is difficult to define all the limitations of the model before it has been used as a tool in policy analysis. It is through the use of the model that any limitations will be revealed. The model, however, should not be viewed as a finished product, but rather as a framework for further research. As limitations develop, changes should be made in the model in order to overcome them.

Some limitations, however, are immediately apparent and should be subjects for further research.

### DATA RELIABILITY

The base case was developed from a very small sample of school districts. More research needs to be done in educational program costing in order to increase confidence in the base case estimates.

### DATA GAPS

A student flow model was integrated into the cost model as a preliminary step toward expanding the model to statewide costs of education rather than just a school district. The attrition factors, however, that influence the size of the student population are not known. More research needs to be done in this area in order to have a better understanding of future size and characteristics of the student population. Further, many programs have been left out of the model entirely. Special education and adult education are not included. Incorporation of these programs would take much more research.

### AGGREGATION

The model may aggregate costs at too high a level. The model works in terms of a mathematics program and does not distinguish between the various types of mathematics courses--algebra, geometry, etc. Whether this is a limitation will only be found through the use of the model in actual school district planning and analysis of alternatives.

Appendix A

DETAILED DESCRIPTION OF THE MODEL

## INTRODUCTION

This appendix provides a detailed description of the model. The nomenclature that is used in the description is defined first. This nomenclature consists of a listing of the indices that are used and the budget category designators. The steps for calculating the number of students and the resulting class requirements is presented in sections on the student population, student load, and class requirement. The cost estimating structure of the model is then presented in program form--Instruction, Instructional Support, Pupil Services, General Support, and Community Services. Lastly, the necessary calculations for the outputs are described.

## INDICES

Many of the variables used in the model are multi-dimensional. Instructional salaries, for example, may vary by the grade and subject. Each dimension in the description of the model is assigned a different index letter. Following is a definition of each dimension along with its index letter:

| *Index* | *Variable* |
|---|---|
| $b$ | Budget category. |
| $i$ | Subject area or program. This variable represents the subject area or program of instruction (reading, science, etc.). |
| $j$ | Grade. This variable represents the grade of instruction. |
| $k$ | Mode of instruction. Examples of modes would be lecture and laboratory. The model only allows for two different modes. |
| $m$ | Age of equipment. |
| $n$ | Course. A course represents a series of subjects that meet graduation requirements. In this model, three courses are specified at high school level--college preparatory, general education, and vocational-technical. Only one course is specified for grades K-8. |
| $t$ | Year. |

BUDGET CODE

In order to examine the budget composition of individual programs, it was necessary to code all program costs by the particular budget category to which they are assigned. The costs of a program would be made up of expenditures in one or more budget categories. For example, the costs of school administration will fall into three budget categories--principals, other costs of instruction, and fixed charges. While the specification of the model that follows is made in program terms, costs are identified by both program and budget category. The budget category designator is termed *b*. The relationship between *b* and the budget categories of the Annual Financial and Budget Report (J-41) are shown below.

| *J-41 Budget Category* | *Budget Category Designator (B)* |
|---|---|
| 100 Administration | 1 |
| 211 Principals' Salaries | 2 |
| 212 Supervisors' Salaries | 3 |
| 213 Teachers' Salaries | 4 |
| 220 Classified Salaries of Instruction | 5 |
| 2XX Other Costs of Instruction* | 6 |
| 400 Health Services | 7 |
| 600 Operation of Plant | 8 |
| 700 Maintenance of Plant | 9 |
| 800 Fixed Charges | 10 |
| 500 Pupil Transportation | 11 |
| 900 Food Services | 12 |
| 1100 Community Services | 13 |
| 1200 Capital Outlay | 14 |

STUDENT POPULATION

One of the main determinants of the cost of education in the State of California will be the size of the student population. A decline in the birth rate and immigration to the state, for example, would translate into a less expansive growth for the school system than was seen in the last decade. In the development of an adequate school finance program, it is important to examine the financial needs of the schools for many years in the future. In recognition of the importance

*The budget category 2XX represents all other 200 level costs that are not specifically delineated.

of student population forecasts, changes in the size of the student population over time have been made an integral feature of the model.

The model requires that the number of students in each grade and course be entered as an input. The model also requires that an "attrition factor" by grade and course be given. The attrition factor represents the number of students in grade $j$ and course $n$ in year $t$ as a fraction of the students in grade $j - 1$ and course $n$ in year $t - 1$. For all grades except kindergarten and the ninth grade, which are special cases, the number of students by grade, course, and year can be calculated as follows:*

$$S(j, n, t) = S[(j + 1 - t), n, 1] \times \prod_{g=j+2-t}^{j} a(g) \quad \begin{cases} j - t > 0 \\ j \neq 1 \\ j \neq 10 \end{cases}$$

$$S(j, n, t) = S[1, n, (t + 1 - j)] \times \prod_{g=2}^{j} a(g) \quad \begin{cases} j - t \leq 0 \\ j \neq 1 \\ j \neq 10 \end{cases}$$

where $S(j, n, t)$ = number of students in the $j$th grade and $n$th course in year $t$,

$a(g)$ = attrition factor.

Kindergarten must be treated as a special case, since the model does not contain any information about the size of the preschool population. To calculate the size of the entering kindergarten class, the model applies a simple growth factor that is an input to the model. The number of students in kindergarten is given by:

$$S(1, n, t) = S(1, n, 1)a(1)^{t-1} \qquad j = 1,$$

where $a(1)$ is one plus the expected rate of growth in kindergarten enrollment expressed in fractional form.

The calculation of the ninth grade enrollment is complicated by the fact that students must be separated into the three different courses. The model performs this separation by applying probability

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*Grade 1 in the model refers to kindergarten. The ninth grade is represented by $j = 10$.

factors that a student will choose a particular course in high school.

$$S(10, n, t) = S[(10 + 1 - t), n, 1] \times SEP(n) \times \prod_{g=(10+2-t)}^{j} a(g) \quad j = 10,$$

where $SEP(n)$ = fraction of entering high school students electing course $n$.

STUDENT LOAD

The student load is the number of students in each grade and subject. Each course represents a different set of subjects that fulfill the requirements for graduation. A probability matrix that contains the probability that a student in a particular grade and course will enroll in a certain subject area is required as an input to the model. For example, a ninth grade student in a college preparatory course could have a choice of enrolling in ten different subject areas. The probabilities of enrolling in each subject are a function of graduation requirements and the student's interest. Our ninth grade student would not take consumer homemaking, but would quite likely enroll in a mathematics subject. To obtain the student load, the number of students by grade and course is multiplied by the subject probability matrix and then the product is summed over all possible courses.

$$SL(i, j, t) = \sum_{n=1}^{N} S(j, n, t) \times P(i, j, n),$$

where $SL(i, j, t)$ = student load--the number of students in the $i$th subject, $j$th grade in year $t$,

$S(j, n, t)$ = number of students in the $j$th grade, $n$th course in year $t$,

$P(i, j, n)$ = the probability that a student in grade $j$, and course $n$ will enroll in the $i$th subject.

$N$ = total number of courses.

CLASS REQUIREMENT

Many costs are related to the number of classes, and not to the number of students. Each class, for example, would have at least one teacher regardless of its size. The first step in determining the number of classes is to divide the number of students (in each subject and grade) by the standard class size. The integer part of the dividend is taken as a first approximation of the number of classrooms required. It could be, however, that when the students are assigned to this many classes, the class size becomes larger than some predetermined maximum. In that case, the model would add one more class. In equation form:

$$C(i,\ j,\ t) = I.P.\left[\frac{SL(i,\ j,\ t)}{SCS(i,\ j)}\right] = r \qquad \frac{SL(i,\ j,\ t)}{r} \leq MCS(i,\ j)$$

$$C(i,\ j,\ t) = I.P.\left[\frac{SL(i,\ j,\ t)}{SCS(i,\ j)}\right] + 1 \qquad \frac{SL(i,\ j,\ t)}{r} > MCS(i,\ j)$$

where $C(i,\ j,\ t)$ = number of classes required for the $i$th subject, $j$th grade in year $t$,

$SL(i,\ j,\ t)$ = student load,

$SCS(i,\ j)$ = standard class size in the $i$th subject and $j$th grade,

$MCS(i,\ j)$ = maximum class size in the $i$th subject and $j$th grade.

$I.P.$ = integer part [e.g., $I.P.(37.6) = 37$].

INSTRUCTIONAL PROGRAM COSTS

The instructional program consists of six cost elements--personnel, fixed charges, materials and textbooks, equipment, and other.

Instructional Personnel

Instructional personnel are divided into three classifications for the purposes of resource estimation: (1) teachers, (2) supervisor and specialists, (3) paraprofessionals. The fixed charges (e.g., retirement) are treated as a separate item within the instructional personnel category.

Teachers. The number of teachers required is determined by the hours per week of instruction per class, the number of hours that a teacher has available for instruction per week, and the number of teachers per classroom hour. It is assumed that a class can be taught in a combination of two modes. The most likely modes would be lecture and laboratory. Each different mode of instruction would have a different resource requirement.

The number of class hours spent in each mode per week per class is required as an input for the model. The total instructional time per week for a subject is the product of the number of classes and the instructional hours per week devoted to that class. An estimate of the number of teacher hours required is made by multiplying the number of instructional hours by the number of teacher hours per instructional hour. The estimated number of teachers is found by dividing the total number of teacher hours by the number of hours that a teacher is available for instruction. The cost of teachers would simply be the number of teachers multiplied by the average salary of a teacher.

$$TC(i, j, t, 4) = \frac{\sum_{k=1}^{2} C(i, j, t)H(i, j, k)THC(i, j, k)}{TE(j)} \times TS(i, j) \times (TI)^{t-1},$$

where $TC(i, j, t, 4)$ = annual cost of teachers,*

$C(i, j, t)$ = number of classes,

$H(i, j, k)$ = number of classhours per week per class,

$THC(i, j, k)$ = teacher hours per classroom hour,

$TS(i, j)$ = average teacher salary,

$TI$ = certificated personnel salary inflation factor,

$TE(j)$ = hours available for instruction per teacher per week.

Supervisory Personnel and Subject Specialists. The number of

*The last dimension in all costs will be the budget classification designator, $b$.

supervisory personnel and subject specialists is estimated as a percentage of the number of teachers. The cost of this type of personnel would be the product of the number and average salary of this type of personnel.

$$SSC(i, j, t, 3) = SR(i, j) \times NT(i, j, t) \times SS(i, j) \times (TI)^{t-1},$$

where $SSC(i, j, t, 3)$ = annual cost of supervisors and specialists,
$SR(i, j)$ = ratio of supervisors and specialists to teachers,
$NT(i, j, t)^{*}$ = number of teachers,
$SS(i, j)$ = average salary of supervisors and specialists,
$TI$ = certificated personnel salary inflation factor.

Paraprofessionals. The number of paraprofessional hours is calculated as the product of the number of class hours and the number of paraprofessional hours per class hour. The number of class hours per week has been calculated previously. The number of paraprofessional hours per class hour is an input to the model. The annual requirement for paraprofessionals would be the weekly requirement, in terms of hours, times the number of weeks in the school year. When this requirement is multiplied by the paraprofessional hourly wage rate, the annual cost of paraprofessionals is obtained as follows:

$$PC(i, j, t, 5) = W \times PR \times \left[\sum_{k=1}^{2} C(i, j, t)H(i, j, k)PHC(i, j, k)\right] \times (PI)^{t-1},$$

where $PC(i, j, t, 5)$ = annual cost of paraprofessionals,
$W$ = number of weeks in school year,
$PR$ = paraprofessional hourly wage rate,
$C(i, j, t)$ = number of classes,

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* $NT(i, j, t) = \dfrac{\sum_{k=1}^{2} C(i, j, t)H(i, j, k)THC(i, j, k)}{TE(j)}$ = number of teachers by grade, subject, and year.

$H(i, j, k)$ = class hours per week,

$PHC(i, j, k)$ = paraprofessional hours per classroom hour,

$PI$ = classified personnel wage inflation factor.

Fixed Charges

There are certain fixed charges that are a function of personnel costs that should be charged to the program. These include annuity fund contributions, old age, survivors, disability, and health insurance, and the like. For the purposes of this model, fixed costs are estimated as a percentage of the total personnel cost.

$$F(i, j, t, 10) = FPT[TC(i, j, t, 4) + SSC(i, j, t, 3)] + PC(i, j, t, 5) \times FCC,$$

where $F(i, j, t, 10)$ = fixed charges to the $i$th subject, $j$th grade in year $t$,

$FPT$ = fixed charge as a percent of salary for certified personnel,

$FCC$ = fixed charge as a percent of salary for classified personnel,

$TC(i, j, t, 4)$ = annual cost of teachers,

$SSC(i, j, t, 3)$ = annual cost of specialists and supervisors,

$PC(i, j, t, 5)$ = annual cost of paraprofessionals.

Textbooks and Materials

The model considers two types of costs in this category--those related to the number of students and those related to the number of classes. The costs that are associated with the number of classes will also vary with whether or not the program is taught in a self-contained classroom.

Student-Related Textbook and Materials. The cost of textbooks and materials per student by grade and subject is entered as an input

to the model.* To obtain the total cost, the cost per student is multiplied by the number of students:

$$STM(i,\ j,\ t,\ 6) = MS(i,\ j) \times SL(i,\ j,\ t) \times (MI)^{t-1},$$

where $STM(i, j, t, 6)$ = cost of student-related textbooks and materials,

$MS(i, j)$ = textbook and material cost per student,

$SL(i, j, t)$ = number of students,

$MI$ = material and equipment inflation factor.

Class-Related Textbook and Material Cost. The cost of class-related textbooks and material will depend on the intensity of use of these materials. In a self-contained classroom for example, teaching materials for reading would be used only once during the day. If the students were to change classrooms during the day, the intensity of use of material could be increased. If it is assumed that depreciation is a function of time and not of use, a cost difference would appear between the self-contained and non-self-contained classroom concepts. The cost estimating procedures for both classroom concepts is presented below.

*Self-contained Classroom.* The cost of classroom-related material under the self-contained classroom concept would just be the product of the material cost per classroom and the number of classes.

$$CSM(i,\ j,\ t,\ 6) = \sum_{k=1}^{2} MC(i,\ j,\ k) \times C(i,\ j,\ t) \times (MI)^{t-1},$$

where $CSM(i, j, t, 6)$ = annual cost of classroom-related textbooks and materials,

$MC(i, j, k)^{\dagger}$ = cost of textbooks and materials per classroom,

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*Textbook and material factors should be treated as annual costs. If the material will last more than 1 year, the cost should be spread evenly over the life of the material. Since material is usually not a high cost item, this simplification should not greatly distort expected expenditure patterns.

†Under the self-contained classroom concept $MC(i, j, k)$ would be zero for $k \neq 1$.

$C(i, j, t)$ = number of classes,

$MI$ = material and equipment inflation factor.

*Non-self-contained Classroom.* The cost of textbooks and material under this concept will depend on the number of classes that can be processed in one classroom during the day. If a classroom is available for $HA(j)$ hours per week, the number of classrooms that would have to be stocked would be given by:*

$$IC(i, j, k, t) = C(i, j, t) \times H(i, j, k)/HA(j) = S \qquad S = \text{integer}$$

$$= I.P.[S] + 1 \qquad S \neq \text{integer}$$

where $IC(i, j, k, t)$ = number of classrooms stocked,

$C(i, j, t)$ = number of classes,

$H(i, j, k)$ = classroom hours of instruction per week per class,

$HA(j)$ = hours available per week per classroom.

Now that the number of stocked classrooms is known, the cost of textbooks and materials can be calculated.

$$CSM(i, j, t, 6) = (IM)^{t-1} \times \sum_{k=1}^{2} MC(i, j, k)IC(i, j, k, t),$$

where $CSM(i, j, t, 6)$ = annual cost of classroom-related textbooks and materials,

$MC(i, j, k)$ = cost of textbooks and materials per classroom,

$IC(i, j, k, t)$ = number of classrooms stocked.

*Total Cost of Textbooks and Materials.* The total cost of textbooks and materials will be the sum of student-related and classroom-related textbook and material costs.

$$TTMC(i, j, t, 6) = STM(i, j, t, 6) + CSM(i, j, t, 6),$$

where $TTMC(i, j, t, 6)$ = annual cost of textbooks and materials,

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*This calculation assumes that there are no restrictions on when the class is held during the week or day.

$STM(i, j, t, 6)$ = annual cost of student-related textbooks and materials,

$CSM(i, j, t, 6)$ = annual cost of classroom-related textbooks and materials.

Equipment

One of the more important alternatives for achieving greater effectiveness with the educational dollar is the substitution of capital for labor. Since equipment may play an important part in the future of education, the model has allowed for detail and flexibility that is not present in some of the other cost categories. Equipment costs are divided into two main categories--normal equipment and special equipment. Normal equipment refers to the standard equipment items that are found in almost all instructional programs (i.e., desks, chairs, etc). Special equipment refers to the equipment that is not standard to the method of instruction normally employed in the teaching of a particular subject (i.e., teaching machines, television, computers, etc.).

Normal Equipment. It is assumed in the model that the normal equipment purchase can be adequately estimated on a per student basis.* This is actually the continuing cost of replacement and not start-up cost of such equipment. The cost of normal equipment per student by grade and subject are entered as inputs to the model. The annual cost of normal equipment would be represented by

$$NEC(i, j, t, 9) = NECF(i, j)SL(i, j, t),$$

where $NEC(i, j, t, 9)$ = annual cost of normal equipment,

$NECF(i, j)$ = cost of normal equipment per student,

$SL(i, j, t)$ = student load.

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*Since data were not available on this category, the base case for the model set the cost of normal equipment equal to zero. The model groups all of those costs under "maintenance" and does not try to allocate them to the educational programs. Future research should attempt to identify normal equipment consumption by program.

<u>Special Equipment</u>. Special equipment consists of two types--student-related and classroom-related equipment.

*Student-Related Special Equipment.* To estimate the cost of new equipment in any year it is essential to know the amount of equipment on hand. In order to keep track of the number and age of equipment already purchased, an inventory account must be established. The inventory records the number of units of equipment for each grade and subject by the age of the equipment. The inventory variable for student-related equipment is defined as

$U(i, j, m)$ = units of equipment that are $m$ years old.

In order to know when the equipment should be discarded, the model also requires an estimate of the life of the equipment.

$LSE(i, j)$ = lifetime of student-related equipment.

(If the life of the equipment is longer than the planning period--5 years--the life of the equipment is set equal to the length of the planning period.)

The demand for student-related equipment is calculated as the product of the number of equipment units per students and the number of students.

$$DSRE(i, j, t) = RSRE(i, j)SL(i, j, t),$$

where $DSRE(i, j, t)$ = demand for student-related equipment units,

$RSRE(i, j)$ = number of equipment units per student,

$SL(i, j, t)$ = student load.

Demand is then compared with supply, which is the inventory variable summed over all possible ages of equipment, as follows:

$$SSRE(i, j, t) = \sum_{m=1}^{LSE(i,j)-1} U(i, j, m),$$

where $SSRE(i, j, t)$ = supply of student-related equipment.

The number of units that will have to be purchased new in any year will be given by

$$USRE(i, j, t) = DSRE(i, j, t) - SSRE(i, j, t) \quad \text{if} \quad DSRE(i, j, t) \geq SSRE(i, j, t)$$
$$USRE(i, j, t) = 0 \quad \text{if} \quad DSRE(i, j, t) < SSRE(i, j, t),$$

where $USRE(i, j, t)$ = number of purchased units.

The cost of student-related equipment in any year will be the product of the number of units purchased and the unit cost of equipment.

$$CSRE(i, j, t, 14) = USRE(i, j, t) \times CUSR(i, j) \times (MI)^{t-1},$$

where $CSRE(i, j, t, 14)$ = annual cost of student-related equipment,
$USRE(i, j, t)$ = number of equipment units purchased,
$CUSR(i, j)$ = unit cost of student-related special equipment.

After making this calculation for a given year, the model automatically ages the inventory by 1 year. The model then proceeds through the identical steps to estimate the cost of equipment in the next year.

*Classroom-Related Equipment*. In order to estimate the cost of classroom-related special equipment, it is necessary to distinguish between the self-contained and non-self-contained model of instruction. The difference between the two concepts would be the number of classrooms that had to be equipped. Under the self-contained model of instruction the number of classrooms equipped is equal to the number of classes

$$CE(i, j, k, t) = C(i, j, k, t).$$

(Note: $k$ is left as a dimension for generality although there is only one mode of instruction possible under the self-contained concept.)

When the mode of instruction is not constrained to the self-contained mode the number of classrooms that need to be equipped would be

$$CE(i, j, k, t) = \left\lfloor \frac{C(i, j, t)H(i, j, k)}{HA(j)} = S \qquad S = \text{integer}$$

$$CE(i, j, k, t) = I.P.[S] + 1 \qquad S \neq \text{integer}$$

The calculation of the cost of classroom-related special equipment now proceeds in similar fashion as the methodology for student-related equipment. An inventory account is established that keeps track of equipment by grade, subject, type, and age. The supply of equipped classrooms is the inventory summed over all ages.

$$SCRE(i, j, k, t) = \sum_{m=1}^{LCE(i,j,k)-1} V(i, j, k, m),$$

where $SCRE(i, j, k, t)$ = supply of special classroom-related equipment. The demand (which is just the number of classrooms that have to be equipped) is compared with the supply to determine the number of classroom units that must be purchased.

$$UCRE(i, j, k, t) = CE(i, j, k, t) - SCRE(i, j, k, t),$$

where $UCRE(i, j, k, t)$ = number of classroom equipped in year $t$, If $U(i, j, k, t)$ turns out to be negative (more classrooms are equipped than are needed), $U(i, j, k, t)$ is set equal to zero.

The cost of equipment is simply the product of the number of units purchased and the unit cost of equipment.

$$CCRE(i, j, t, 14) = \sum_{k=1}^{2} UCRE(i, j, k, t)CUCR(i, j, k)MI^{t-1},$$

where $CCRE(i, j, t, 14)$ = cost of classroom-related special equipment,
$CUCR(i, j, k)$ = unit cost of special classroom-related equipment.

After the completion of the calculations for 1 year, the inventory is aged by 1 year and the process repeated for the next year.

Other

Educational alternatives may involve the use of resources outside of the traditional classroom environment. Moreover, some alternatives may require more extensive use of support services that must be taken into account for accurate cost estimating. To cover some of these contingencies three cost items are included under this miscellaneous cost category--transportation, maintenance related to the instructional program, and a broad catch-all category termed "miscellaneous."

Transportation Related to the Instructional Program.* The cost of transportation related to the instructional program is estimated as the product of the number of students and the cost of transportation per student as follows:

$$SRT(i,\ j,\ t,\ 11) = TF(i,\ j)SL(i,\ j,\ t)MI^{t-1},$$

where $SRT(i,\ j,\ t,\ 11)$ = cost of instruction-related transportation,

$TF(i,\ j)$ = cost per student of instruction-related transportation,

$SL(i,\ j,\ t)$ = student load,

$MI$ = material inflation factor.

Maintenance Related to the Instructional Program. An eventual goal of the educational costing is to relate all direct expenditures to the proper program. If, for example, a chemistry program requires an inordinate amount of maintenance, the decisionmaker must know this in order to properly assess the consequences of expanding or contracting the chemistry program. Unfortunately, the state of educational

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*It is assumed in the model that only the incremental costs of using the buses for instruction-related purposes is charged to this category. The cost of bus drivers has been charged to the bus transportation program. If, in fact, more drivers are needed or they are diverted from other tasks, the cost of the drivers can be included in this cost category. The model, however, will not crosswalk the fixed charges associated with these personnel and transfer them to the proper J-41 budgetary category. This, of course, will be a negligible error within the budget categories. Moreover, the estimate of total cost will be unbiased.

costing is not far enough advanced to provide that type of information for use in the model. The approach in the model has been to consider two types of maintenance. The base case maintenance is estimated as a function of the number of students and is not sensitive to changes in the instructional program.* The costs reported in this category are those associated with special equipment. As a first cut, it has been assumed that maintenance cost can be estimated as a percentage of the cost of special equipment.

$$ISM(i, j, t, 9) = \left[SSRE(i, j, t) \times CUSR(i, j) + \sum_{k=1}^{2} SCRE(i, j, k, t) \times CUCR(i, j, k)\right] \times MF(i, j) \times (MI)^{t-1},$$

where $ISM(i, j, t, 9)$ = annual cost of maintenance related to instruction,

$SSRE(i, j, t)$ = number of student-related equipment units,

$CUSR(i, j)$ = unit cost of student-related equipment,

$SCRE(i, j, k, t)$ = number of specially equipped classrooms,

$CUCR(i, j, k)$ = cost of classroom-related equipment units,

$MF(i, j)$ = maintenance cost as a percent of original equipment cost,

$MI$ = material inflation factor.

Miscellaneous. Miscellaneous costs are estimated on a per student basis. This cost category covers any items that cannot be placed in any of the other cost categories.

$$M(i, j, t, 6) = FM(i, j)SL(i, j, t),$$

where $M(i, j, t, 6)$ = annual cost of miscellany,

$FM(i, j)$ = per student cost of miscellany,

$SL(i, j, t)$ = number of students.

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*See p. 48 for a description of maintenance costs.

## INSTRUCTIONAL SUPPORT COSTS

Instructional support includes two main categories of activities--instructional administration and instructional media.

### Instructional Administration

The definition of instructional administration differs among the BPM,* the recommended PPB structure,† and what is presented in the model. The BPM defines instructional administration as essentially principals, assistant principals, and supervisors. The PPB structure places principals under school administration. In the model, however, we have followed the PPB structure by placing principals in school administration, but deviated to some extent by placing supervisors in the instructional program. The instructional administration referred to in the model includes only in-service training and sabbatical leave. There are arguments for placing even these costs in the instructional program. The overriding concern, however, is that the decisionmaker can see the resource implications of changes in policy. Whether the costs are shown in instructional support or instruction would appear to have, at most, a second order effect in illuminating the decision.

Instructional administration is estimated as a linear relationship to the number of teachers as follows:

$$IA(t,\ 4) = (SL + IT) \times NT(t) \times TI^{t-1},$$

where $IA$ = annual cost of instructional administration,

$SL$ = cost of sabbatic leave per teacher,

$IT$ = cost of in-service training per teacher,

$NT(t)$ = number of teachers,

$TI$ = certificated personnel salary inflation factor.

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*Edwin Harper, "Basic Program Support for the Public Schools--Draft," Department of Education, Sacramento, November 12, 1970.

†*Planning, Programming, and Budgeting System Manual (Preliminary)*, California State Department of Education, Sacramento, 1970.

Instructional Media

Instructional media includes two major cost categories--audio visual and library support.

Audio Visual. The cost of audio visual support varies with the level of instruction. Because this cost item is small in comparison to the total budget, no attempt is made in the model to identify the specific resources (personnel, supplies, equipment) that are consumed in the program. Similarly, the various costs that make up this category are not identified by budget category. All costs are assigned to "other cost of instruction."

$$AV(t, 6) = [AVCE \times NE(t) + AVCH \times NH(t)]PI^{t-1},$$

where $AV(t, 6)$ = annual cost of audio visual support,

$AVCE$ = cost of audio visual support per elementary school student,

$AVCH$ = cost of audio visual support per high school student,

$PI$ = classified personnel wage inflation factor,

$NE(t)$ = number of elementary school students,

$NH(t)$ = number of high school students.

Library Support. The cost of library support varies by level of instruction. The costs of library support are assigned to the "other costs of instruction category," with fringe benefits associated with library personnel assigned to the fixed charge budget category.

$$LS(t, 6) = (EPLR \times PLSS \times TI^{t-1} + BMES \times MI^{t-1}\ CCES \times PI^{t-1})NE(t)$$
$$+ (HPLR \times PLSS \times TI^{t-1} + BMHS \times MI^{t-1} + CCHS \times PI^{t-1})NH(t);$$
$$LS(t, 10) = (EPLR \times PLSS \times TI^{t-1}\ FPT + CCES \times PI^{t-1}\ FCC)NE(t)$$
$$+ (HPLR \times PLSS \times TI^{t-1}\ FPT + CCHS \times PI^{t-1}\ FCC)NH(t);$$
$$LS(t) = \sum_b LS(t, b),$$

where $LS(t)$ = annual cost of library support,

$EPLR$ = ratio of librarians to elementary school students,

$HPLR$ = ratio of librarians to high school students,

$PLSS$ = annual salary of librarians,

$BMES$ = annual cost of library books and supplies per elementary school student,

$BMHS$ = annual cost of library books and supplies per high school student,

$CCES$ = annual cost of library clerical support per elementary school student,

$CCHS$ = annual cost of library clerical support per high school student.

PUPIL SERVICES COSTS

Pupil services in Level V of the PPB program structure include the following functions:* Health and welfare, guidance and counseling, attendance, food services, and transportation. For the purposes of the model, it was found more convenient to group welfare with attendance rather than with health. Attendance and welfare are reported in the same general budget classification, while health expenditures are reported separately. To group health and welfare together would create problems in the crosswalk between the traditional and program budget without a commensurate increase in program information.

Attendance and Welfare

The cost of attendance and welfare services is estimated as a function of the number of students.

$$\begin{aligned} AW(t, 6) = {} & [RAE \times WAE \times (TI)^{t-1} + RAC \times WCE \times (PI)^{t-1} \\ & + ASE \times (MI)^{t-1}]NE(t) + [RAH \times WAE \times (TI)^{t-1} \\ & + RHC \times WCE \times (PI)^{t-1} + ASH \times (MI)^{t-1}]NH(t); \end{aligned}$$

*See *Planning, Programming, and Budgeting System Manual*, op. cit., for a definition of the various levels in the PPB structure.

$$AW(t, 10) = [RAE \times WAE \times FPT \times (TI)^{t-1} + RAC \times WCE \times FCC \times (PI)^{t-1}]NE(t) + [RAH \times WAE \times FPT \times (TI)^{t-1} + RHC \times WCE \times FCC \times (PI)^{t-1}]NH(t),$$

$$AW(t) = \sum_{b} AW(t, b),$$

where $AW(t)$ = annual cost of attendance and welfare services,

$RAE$ = ratio of attendance supervisors to elementary school students,

$RAH$ = ratio of attendance supervisors to high school students,

$WAE$ = annual salary of attendance supervisor,

$RAC$ = ratio of attendance clerks to elementary school students,

$RHC$ = ratio of attendance clerks to high school students,

$WCE$ = annual salary of a clerk,

$ASE$ = annual cost of attendance supplies per elementary school student,

$ASH$ = annual cost of attendance supplies per high school student.

## Health

In determining the proper level of health care to be provided through the school system, it is important to consider this form of health services delivery as only one alternative. As health needs and the availability of other alternatives vary among school districts, it would seem reasonable to expect differences in the school health program. Without a knowledge of either the needs or existing alternatives, it is impossible to design an efficient school health program. Moreover, it is not clear that the state should serve as a balance wheel in equalizing the availability of health care through the school system. Therefore, the model estimates the cost of the health program independently of the social and economic characteristics of the school district. The form of the estimating relationship is similar to that of the BPM.

$$HC(t, 7) = [RNS \times SN \times (TI)^{t-1} + RC \times WCE \times (PI)^{t-1} + HS \times (MI)^{t-1}]NS(t);$$

$$HC(t, 10) = [RNS \times SN \times FPT \times (TI)^{t-1} + RC \times WCE \times FCC \times (PI)^{t-1}]NS(t);$$

$$HC(t) = \sum_b HC(t, b),$$

where $HC(t)$ = annual cost of the health program,

$RNS$ = ratio of nurses to students,

$SN$ = annual salary of school nurse,

$RC$ = ratio of health clerks to students,

$WCE$ = annual salary of a clerk,

$HS$ = cost of health supplies per student.

Guidance and Counseling

Guidance and counseling costs are estimated as a linear function of the number of elementary and number of high school students.

$$GC(t, 6) = (ERG \times WGC \times TI^{t-1} + ERGC \times WCE \times PI^{t-1} + ESGC \times MI^{t-1})NE(t) + (HRG \times WGC \times TI^{t-1} + HRC \times WCE \times PI^{t-1} + HSGC \times MI^{t-1})NH(t);$$

$$GC(t, 10) = (ERG \times WGC \times FPT \times TI^{t-1} + ERGC \times WCE \times FCC \times PI^{t-1})NE(t) + (HRG \times WGC \times FPT \times TI^{t-1} + HRGC \times WCE \times FCC \times PI^{t-1})NH(t);$$

$$GC(t) = \sum_b GC(t, b),$$

where $GC(t)$ = annual cost of guidance and counseling,

$ERG$ = ratio of guidance counselors to elementary school students,

$HRG$ = ratio of guidance counselors to high school students,

$WGC$ = annual salary of a guidance counselor,

$ERGC$ = ratio of guidance and counseling clerks to elementary school students,

$HRGC$ = ratio of guidance and counseling clerks to high school students,

$WCE$ = annual salary of a clerk,

$ESGC$ = annual cost of guidance materials per elementary school student,

$HSGC$ = annual cost of guidance materials per high school student.

Food Services

The cost of food service is assumed to be directly proportional to the number of students. The per capita cost of food service for elementary and high school are inputs to the model. For the base case, these inputs are set equal to zero. All costs are assigned to the food service budget category (900) of the J-41 reporting format.

$$FS(t,\ 12) = ESF \times NE(t) + HSF \times NH(t),$$

where $FS(t)$ = annual cost of food service,

$ESF$ = cost of food service per elementary school student,

$HSF$ = cost of food service per high school student.

Transportation

The operating costs of the transportation program in a district will depend on many variables. The number of students to be transported and their geographical distribution are certainly key determinants. The type of buses that the district operates, the school schedule, and the bus maintenance policy can greatly affect the cost of operating the transportation program. The purpose of the model, however, was not to serve as a tool in decisionmaking about transportation policy. To look at transportation one would need a much more detailed model than is presented here. The estimating relationship used here yields an accurate picture of total costs, but should not be used for evaluating changes at the margin.

$$TOC(t,\ 11) = 2.87 \times TN(t)^{.32} \times M^{.67},$$

where $TOC(t)$ = annual operating cost of the transportation program,

$TN(t)$ = number of students transported,

$M$ = total miles driven per year.

The cost of fixed charges associated with this program is estimated as 7.5 percent of the annual operating cost of the transportation program.

$$TOC(t,\ 10) = .075 \times TOC(t,\ 11).$$

The total cost of transportation would be the sum of these two components.

$$TOC(t) = \sum_b TOC(t,\ b).$$

GENERAL SUPPORT COSTS

The general support category includes the cost categories of school maintenance, operations, school administration, and district administration. The construction of cost factors for these categories should proceed in a fashion similar to that for the instructional program. Exemplary programs in maintenance and operation should be found and their cost behavior simulated in model form. School plants, however, may have many distinguishing characteristics to make the establishment of a single cost factor on either a per student or square foot basis an unrealistic solution. As in the case of pupil services, there was not sufficient time to make a detailed study of the determinants of cost in these budget categories. The estimating relationships presented below are based on other research or on the findings of a preliminary study of the PPB-pilot-school districts.

Operations

Based on the study of the PPB districts,* the following estimating relationships were derived for the number of operations personnel.

$$OP(t) = .025 \times NS(t)^{.875},$$

*Four school districts that are in the process of implementing PPB were visited in the course of the research reported here. Information on the program cost from these districts was used in establishing the base case data as reported in Appendix B.

where $OP(t)$ = number of operations personnel,

$NS(t)$ = total number of students.

The annual cost of operations is then estimated by

$$AOC(t,\ 8) = OP(t) \times CW \times PI^{t-1} + (CS + UPS)MI^{t-1} \times NS(t);$$

$$AOC(t,\ 10) = IRL \times NS(t) + FCC \times OP(t) \times CW \times PI^{t-1};$$

$$AOC(t) = \sum_{b} AOC(t,\ b),$$

where $AOC(t)$ = annual cost of operations,

$CW$ = annual salary of operations personnel,

$CS$ = cost of custodial supplies per student,

$UPS$ = cost of utilities per student,

$IRL$ = cost of insurance, rentals, and leases per student.

Maintenance

Maintenance is defined as those activities required to repair school property--including grounds, buildings, and equipment--and replacement of school equipment to approximately its original condition of completeness and efficiency. An estimating relationship for the number of maintenance personnel was derived from an examination of several of the pilot PPB districts.

$$MP(t) = .032 \times NS(t)^{.725},$$

where $MP(t)$ = number of maintenance personnel,

$NS(t)$ = number of students.

The cost of maintenance is then estimated by the following:

$$AMC(t,\ 9) = MP(t) \times MW \times PI^{t-1} + SRM \times MI^{t-1} \times NS(t);$$

$$AMC(t,\ 10) = MP(t) \times MW \times FCC \times PI^{t-1};$$

$$AMC(t) = \sum_{b} AMC(t,\ b),$$

where $AMC(t)$ = annual cost of school maintenance,

$MW$ = annual salary of maintenance personnel,

$SRM$ = cost of maintenance materials per student.

## School Administration

School administration encompasses those activities that have as their overall purpose the administration of a single school (or several schools, but not an entire district). It consists of the activities performed by the principal, assistant principals, and other assistants.

The cost of school administration is estimated as a function of the number of teachers and the amount of support provided each administrator. The number of administrators is estimated as follows:

$$NA(t) = [NT(t) \times ATR] = q \qquad q = \text{integer}$$
$$NA(t) = I.P.[q] + 1 \qquad q \neq \text{integer}$$

where $NA(t)$ = number of administrators,

$NT(t)$ = number of teachers,

$ATR$ = ratio of administrators to teachers.

The cost of school administration becomes:

$$SAC(t,\ 2) = NA(t) \times PW \times TI^{t-1};$$
$$SAC(t,\ 6) = NA(t) \times PS \times MI^{t-1} + NA(t) \times ACS \times PI^{t-1};$$
$$SAC(t,\ 10) = NA(t) \times (FPT \times PW \times TI^{t-1} + ACS \times FCC \times PI^{t-1});$$
$$SAC(t) = \sum_{b} SAC(t,\ b),$$

where $SAC(t)$ = annual cost of school administration,

$PW$ = annual salary of school administrator,

$PS$ = annual cost of administrative supplies and travel per administrator,

$ACS$ = annual cost of administrative clerical help per administrator.

## District Administration

District administration includes those activities performed by

the school board, the superintendent, and his staff in the management of the affairs of the school district. The determinants of the cost of district administration and the proper level of such costs were research questions that could not be addressed in the study period. From the review of several of the PPB districts the following estimating relationship was derived for use in the base case.

$$DAC(t, 1) = 2922 \times NT(t)^{.8},$$

where $DAC(t)$ = annual cost of district administration,

$NT(t)$ = number of teachers.

The fixed charges in this program category are taken as 7.80 percent of the total cost of district administration.

$$DAC(t, 10) = .0780 \times DAC(t, 1).$$

The total cost of district administration is given by

$$DAC(t) = \sum_{b} DAC(t, b).$$

COMMUNITY SERVICES

Community services has been included in the model for the sake of completeness. No estimating relationship has been derived for this category. The amount of community service per student can be entered as an input. For the base case, however, this input has been set to zero.

$$CS(t, 13) = CSE \times NE(t) + CSH \times NH(t),$$

where $CS(t, 13)$ = annual cost of community service,

$CSE$ = cost of community service per elementary student,

$CSH$ = cost of community service per high school student.

## CALCULATION OF MODEL OUTPUTS

The model has three output options: (1) total program cost, (2) total cost by budget category, and (3) program cost by budget category.

### Total Program Cost

Since the cost-estimating structure of the model is in program form, the calculation of the outputs requires little additional effort.

Instructional Program. The cost of each instructional program in each grade and year, $INT(i, j, t)$, is the sum of the cost of the various resources going into the program as follows:

$$\begin{aligned} INT(i, j, t) = {} & TC(i, j, t, 4) + SSC(i, j, t, 3) + PC(i, j, t, 5) \\ & + F(i, j, t, 10) + STM(i, j, t, 6) + CSM(i, j, t, 6) \\ & + NEC(i, j, t, 9) + CSRE(i, j, t, 14) + CCRE(i, j, t, 14) \\ & + SRT(i, j, t, 11) + ISM(i, j, t, 9) + M(i, j, t, 6). \end{aligned}$$

The cost of the program is only reported by level of instruction (elementary and high school) and not by grade. To obtain the instructional program cost by program and level, $INT(i, j, t)$ must be summed over the appropriate interval as follows:

$$EINT(i, t) = \sum_{j=1}^{9} INT(i, j, t);$$

$$HINT(i, t) = \sum_{j=10}^{13} INT(i, j, t),$$

where $EINT(i, t)$ = instructional cost of the $i$th program in elementary school,

$HINT(i, t)$ = instructional cost of the $i$th program in high school.

The total cost of instruction for any year can be obtained by summing $EINT(i, t)$ and $HINT(i, t)$ over all the programs (i.e., summing over the dimension $i$).

To find the cost per student, the cost of the individual program is divided by the number of students in the program.

$$CSEI(i, t) = \frac{EINT(i, t)}{\sum_{j=1}^{9} SL(i, j, t)};$$

$$CSHI(i, t) = \frac{HINT(i, t)}{\sum_{j=10}^{13} SL(i, j, t)},$$

where $CSEI(i, t)$ = cost per student of the $i$th program in elementary school,

$CSHI(i, t)$ = cost per student of the $i$th program in high school.

The annual cost of instruction per student in elementary and high school is given by

$$AEI(t) = \frac{\sum_{i} EINT(i, t)}{\sum_{j=1}^{9} \sum_{n} S(j, n, t)};$$

$$AHI(t) = \frac{\sum_{i} HINT(i, t)}{\sum_{j=9}^{13} \sum_{n} S(j, n, t)},$$

where $AEI(t)$ = annual cost per student of elementary education,

$AHI(t)$ = annual cost per student of high school education,

$S(j, n, t)$ = number of students in $j$th grade, $n$th course, in year $t$.

Instructional Support. The annual cost of instructional support is calculated as the sum of its two components--instructional administration and instructional media. Instructional media, in turn, is composed of audio visual support and library support.

$IA(t, 4)$ = annual cost of instructional administration,

$AV(t, 6)$ = annual cost of audio visual support,

$LS(t)$ = annual cost of library support,

$IM(t) = AV(t, 6) + LS(t)$ = annual cost of instructional media,

$IS(t) = IA(t) + IM(t)$ = annual cost of instructional support.

The cost per student of each of these programs is found by dividing by the total number of students in the district.

Pupil Services. The components of pupil services have previously been calculated. The total cost of pupil services can be represented by:

$$PS(t) = AW(t) + HC(t) + GC(t) + FS(t, 12) + TOC(t),$$

where $PS(t)$ = annual cost of pupil services,

$AW(t)$ = annual cost of attendance and welfare services,

$HC(t)$ = annual cost of health services,

$GC(t)$ = annual cost of guidance and counseling services,

$FS(t, 12)$ = annual cost of food services,

$TOC(t)$ = annual cost of school transportation.

The per student costs of each of the components and the total cost of pupil services is found by dividing the cost of each by the total number of students.

General Support. The general support category comprises the individual programs whose costs have been calculated previously. The total cost of the general support program is, therefore, found by summing the cost of its components as follows:

$$GS(t) = AOC(t) + AMC(t) + SAC(t) + DAC(t),$$

where $GS(t)$ = annual cost of general support,

$AOC(t)$ = annual cost of operations,

$AMC(t)$ = annual cost of maintenance,

$SAC(t)$ = annual cost of school administration,

$DAC(t)$ = annual cost of district administration.

Community Services. The cost of community services has been calculated [$CS(t, 13)$] previously. The cost per student is found by dividing $CS(t, 13)$ by the total number of students in year $t$.

Total Cost by Budget Category

Following are the costs that are assigned to each budget category in equation form:

$$B(100, t) = DAC(t, 1);$$

$$B(211, t) = SAC(t, 2);$$

$$B(212, t) = \sum_{i} \sum_{j=1}^{13} SSC(i, j, t, 3);$$

$$B(213, t) = \sum_{i} \sum_{j=1}^{13} TC(i, j, t, 4) + IA(t, 4);$$

$$B(220, t) = \sum_{i} \sum_{j=1}^{13} PC(i, j, t, 5);$$

$$B(2XX, t) = \sum_{i} \sum_{j=1}^{13} [STM(i, j, t, 6) + CSM(i, j, t, 6) + M(i, j, t, 6)]$$

$$+ AV(t, 6) + LS(t, 6) + AW(t, 6) + GC(t, 6) + SAC(t, 6);$$

$$B(400, t) = HC(t, 7);$$

$$B(600, t) = AOC(t, 8);$$

$$B(700, t) = \sum_{i} \sum_{j=1}^{13} [NEC(i, j, t, 9) + ISM(i, j, t, 9)] + AMC(t, 9);$$

$$B(800, t) = \sum_{i} \sum_{j=1}^{13} F(i, j, t, 10) + LS(t, 10) + AW(t, 10) + HC(t, 10)$$

$$+ GC(t, 10) + TOC(t, 10) + AOC(t, 10) + AMC(t, 10)$$

$$+ SAC(t, 10) + DAC(t, 10);$$

$$B(500, t) = \sum_{i} \sum_{j=1}^{13} SRT(i, j, t, 11) + TOC(t, 11);$$

$$B(900, t) = FS(t, 12);$$

$$B(1100, t) = CS(t, 13);$$

$$B(1200,\ t) = \sum_{i} \sum_{j=1}^{13} [CSRE(i,\ j,\ t,\ 14) + CCRE(i,\ j,\ t,\ 14)].$$

## Program Cost by Budget Category

Stored within the program is a matrix that relates the cost of a program by budget category. For example, the cost of the $i$th program in elementary school would be formed in matrix display for each year of the planning period as follows:

| | 100 | 211 | 212 | 213 | 220 | 2XX | 400 | 600 | 700 | 800 | 500 | 900 | 1100 | 1200 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elementary school program $i$ | | | $a$ | $b$ | $c$ | $d$ | | | | $e$ | | | | |

where $a = \sum_{j=1}^{9} SSC(i,\ j,\ t,\ 3)$,

$$b = \sum_{j=1}^{9} TC(i,\ j,\ t,\ 4),$$

$$c = \sum_{j=1}^{9} PC(i,\ j,\ t,\ 5),$$

$$d = \sum_{j=1}^{9} STM(i,\ j,\ t,\ 6) + \sum_{j=1}^{9} CSM(i,\ j,\ t,\ 6) + \sum_{j=1}^{9} M(i,\ j,\ t,\ 6),$$

$$e = \sum_{j=1}^{9} F(i,\ j,\ t,\ 10).$$

The cost of the various support programs has already been identified by budget category. Only a simple readout of the matrix is necessary for this output.

## Appendix B

## BASE CASE INPUTS TO THE EDUCATION COST MODEL

Inputs to the Education Cost Model (ECM) for the base case were obtained primarily from an analysis of several pilot PPB school districts, Basic Program Model* (BPM), and by assumption. The base case as used here is representative of an average California K-12 district without special and adult educational programs. Inputs are in five categories: (1) non-dimensional, (2) one-dimensional, (3) two-dimensional, (4) three-dimensional, and (5) four-dimensional. On the following pages the category, the description, the numerical input for the base case, and the source of the base case value input are shown in tabular form. All the cost inputs are for fiscal 1969-1970.

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*Edwin Harper's BPM for the Statewide Council on Long-Range Planning, unpublished.

Table 3

CATEGORY 1: NON-DIMENSIONAL INPUTS

| *No.* | *Description* | *Input* | *Source* |
|---|---|---|---|
| 1 | Weeks per school year | 36 | California school year |
| 2 | Number of students transported | 4100 | Assumed |
| 3 | Transportation miles | 520,000 | Assumed |
| 4 | Fraction of eighth-grade students to curriculum 1 (voc) | .33 | Assumed |
| 5 | Fraction of eighth-grade students to curriculum 2 (general ed) | .33 | Assumed |
| 6 | Fraction of eighth-grade students to curriculum 3 (CP) | .33 | Assumed |
| 7 | Teacher and supervisor wage inflation factor | .05 | Assumed |
| 8 | Paraprofessional wage rate | $2.50/hr | Assumed |
| 9 | Paraprofessional wage inflation factor | .05 | Assumed |
| 10 | Material and equipment inflation factor | .05 | Assumed |
| 11 | Annual salary of administrators | $20,000/yr[a] | BPM |
| 12 | Annual salary of maintenance personnel | $6,500/yr | BPM |
| 13 | Annual salary of operation personnel | $5,900/yr | BPM |
| 14 | Annual salary of nurses | $10,230/yr | BPM |
| 15 | Annual salary of clerks | $5,600/yr | BPM |
| 16 | Annual salary of counselors | $13,500/yr | BPM |
| 17 | Annual salary of attendance and welfare (A&W) supervisors | $13,500/yr | BPM |
| 18 | Fixed charges as a fraction of certified salaries | .07[b] | BPM |
| 19 | Fixed charges as a fraction of classified salaries | .12 | BPM |
| 20 | Cost of sabbatic leave per teacher | 0 | Assumed |
| 21 | Cost of in-service training per teacher | $15 | BPM |
| 22 | Cost of audio visual support per elementary school student | $3.29/student | BPM |
| 23 | Cost of audio visual support per high school student | $5.78/student | BPM |

[a]Wage rates shown in the BPM were for 1968-1969. They have been increased by 5 percent to represent 1969-1970 costs.

[b]This percentage varies and is less for higher salaried personnel such as administrators and supervisors; however, the simplifying assumption of 7 percent was used to not unduly complicate the model.

Table 3--continued

| *No.* | *Description* | *Input* | *Source* |
|---|---|---|---|
| 24 | Ratio of professional librarians to elementary school students | .0004 | BPM |
| 25 | Ratio of professional librarians to high school students | .001 | BPM |
| 26 | Annual salaries of librarians | $11,560/yr | BPM |
| 27 | Annual cost of library books and supplies per elementary school student | $3.33/student | BPM |
| 28 | Annual cost of library books and supplies per high school student | $4.00/student | BPM |
| 29 | Annual cost of library clerical support per elementary school student | $2.00/student | BPM |
| 30 | Annual cost of library clerical suppert per high school student | $3.00/student | BPM |
| 31 | Ratio of attendance and welfare supervisors to number of elementary students | .0001 | BPM |
| 32 | Ratio of attendance and welfare supervisors to number of high school students | .0004 | BPM |
| 33 | Ratio of attendance clerks to number of elementary school students | .00025 | BPM |
| 34 | Ratio of attendance clerks to number of high school students | .001 | BPM |
| 35 | Attendance and welfare materials, supplies, and travel per elementary student | $0.50/student | BPM |
| 36 | Attendance and welfare materials, supplies, and travel per high school student | $1.00/student | BPM |
| 37 | Ratio of nurses to number of students | .0006 | PPB districts |
| 38 | Ratio of health clerks to number of students | .0003 | PPB districts |
| 39 | Health supplies per student | $0.50/student | BPM |
| 40 | Ratio of counselors to elementary school students | .000555 | BPM |
| 41 | Ratio of counselors to high school students | .00222 | BPM |
| 42 | Ratio of guidance and counseling clerks to elementary school students | .000277 | BPM |
| 43 | Ratio of guidance and counseling clerks to high school students | .000555 | BPM |

Table 3--continued

| *No.* | *Description* | *Input* | *Source* |
|---|---|---|---|
| 44 | Guidance and counseling materials per elementary school student | $2.00/student | BPM |
| 45 | Guidance and counseling materials per high school student | $2.25/student | BPM |
| 46 | Cost of food services per elementary school student | 0 | Assumed |
| 47 | Cost of food services per high school student | 0 | Assumed |
| 48 | Cost of maintenance supplies per student | $16.75/student | PPB districts |
| 49 | Cost of custodial supplies per student | $4.20/student | PPB districts |
| 50 | Cost of utilities per student | $17.00/student | PPB districts |
| 51 | Cost of insurance, rentals, and leases per student | $6.25/student | PPB districts |
| 52 | Ratio of administrators to teachers | .0435 | PPB districts |
| 53 | Cost of administrative supplies per administrator | $500 | PPB districts |
| 54 | Cost of administrative clerical support per administrator | $11,200[c] | PPB districts |
| 55 | Cost of community services per elementary school student | 0 | Assumed |
| 56 | Cost of community services per high school student | 0 | Assumed |

[c]This cost was derived from data that showed two clerks per principal and vice principal at an annual salary of $5600 per clerk.

Table 4

CATEGORY 2: ONE-DIMENSIONAL INPUTS

| *No.* | *Description* | *Input* | *Source* |
|---|---|---|---|
| 1 | Teacher equivalent hours per week | 30, K | California |
| | | 22.5, 1-3 | California |
| | | 30, 4-6 | California |
| | | 25, 7-8 | California |
| | | 25, 9-12 | PPB districts |
| 2 | Classroom hours available per classroom per week | 30, K-12 | Assumed |
| 3 | Class self-contained designator[a] | 1, K-8 | Assumed |
| | | 0, 9-12 | Assumed |

[a]0 = not self-contained, 1 = self-contained.

Table 7

CATEGORY 3: TWO-DIMENSIONAL INPUTS

No. 3: Specialists per Teacher

| | Grade | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Subject* | *K* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
| 1 Reading | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | 0 | 0 | 0 | 0 |
| 2 English | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 |
| 3 Mathematics | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 |
| 4 Social Science | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 |
| 5 Science | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 |
| 6 Fine Arts | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 |
| 7 Health | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | 0 | 0 | 0 | 0 |
| 8 Physical Education | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 |
| 9 Foreign Language | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .02 | .02 | .02 | .02 |
| 10 Industrial Arts | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .02 | .02 | .02 | .02 |
| 11 Driver Education | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .02 | .02 | .02 | .02 |
| 12 Agriculture | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .02 | .02 | .02 | .02 |
| 13 Distributive Education | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .02 | .02 | .02 | .02 |
| 14 Office | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .02 | .02 | .02 | .02 |
| 15 Homemaking | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .02 | .02 | .02 | .02 |
| 16 Trade and Industrial | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .02 | .02 | .02 | .02 |
| 17 Other, 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 Other, 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 Other, 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 Other, 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

SOURCE: Folsom, Cordova, San Jose, and El Monte.

Table 5

CATEGORY 3: TWO-DIMENSIONAL INPUTS

No. 1: Elementary School Student Attrition

| *Grade* | *Attrition Factor* |
|---|---|
| K | 1.0 |
| 1 | 1.0 |
| 2 | 1.0 |
| 3 | 1.0 |
| 4 | 1.0 |
| 5 | 1.0 |
| 6 | 1.0 |
| 7 | 1.0 |
| 8 | 1.0 |

SOURCE: Assumed.

Table 6

CATEGORY 3: TWO-DIMENSIONAL INPUTS

No. 2: High School Student Attrition

| | *Attrition Factor* | | |
|---|---|---|---|
| *Grade* | *Vocational (1)* | *General Educ (2)* | *College Prep (3)* |
| 9 | 1.0 | 1.0 | 1.0 |
| 10 | 1.0 | 1.0 | 1.0 |
| 11 | 1.0 | 1.0 | 1.0 |
| 12 | 1.0 | 1.0 | 1.0 |

SOURCE: Assumed.

Table 8

CATEGORY 3: TWO-DIMENSIONAL INPUTS

No. 4: Normal Classroom Size, Students

| | Grade | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Subject* | *K* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
| 1 Reading | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 0 | 0 | 0 | 0 |
| 2 English | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| 3 Mathematics | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| 4 Social Science | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| 5 Science | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| 6 Fine Arts | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 35 | 35 | 35 | 35 |
| 7 Health | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 0 | 0 | 0 | 0 |
| 8 Physical Education | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 40 | 40 | 40 | 40 |
| 9 Foreign Language | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 30 | 30 | 30 |
| 10 Industrial Arts | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 26 | 26 | 26 | 26 |
| 11 Driver Education | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 18 |
| 12 Agriculture | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 26 | 26 | 26 | 26 |
| 13 Distributive Education | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 26 | 26 | 26 | 26 |
| 14 Office | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 35 | 35 | 35 | 35 |
| 15 Homemaking | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 26 | 26 | 26 | 26 |
| 16 Trade and Industrial | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 26 | 26 | 26 | 26 |
| 17 Other, 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 Other, 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 Other, 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 Other, 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

SOURCE: PPB District and assumed.

Table 9

CATEGORY 3: TWO-DIMENSIONAL INPUTS

No. 5: Maximum Classroom Size, Students

| | Grade | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Subject* | *K* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
| 1 Reading | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 0 | 0 | 0 | 0 |
| 2 English | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| 3 Mathematics | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| 4 Social Science | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| 5 Science | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| 6 Fine Arts | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 40 | 40 | 40 | 40 |
| 7 Health | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 0 | 0 | 0 | 0 |
| 8 Physical Education | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 45 | 45 | 45 | 45 |
| 9 Foreign Language | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 35 | 35 | 35 | 35 |
| 10 Industrial Arts | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 30 | 30 | 30 |
| 11 Driver Education | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 18 |
| 12 Agriculture | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 30 | 30 | 30 |
| 13 Distributive Education | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 30 | 30 | 30 |
| 14 Office | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 40 | 40 | 40 |
| 15 Homemaking | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 30 | 30 | 30 |
| 16 Trade and Industrial | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 30 | 30 | 30 |
| 17 Other, 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 Other, 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 Other, 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 Other, 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

SOURCE: Assumed.

Table 10

CATEGORY 3: TWO-DIMENSIONAL INPUTS

No. 6 through No. 10

| *Description* | *Grade* | *All Subjects ($)* |
|---|---|---|
| 6 Annual teacher salary | K-8 | 9,300 |
| | 9-12 | 10,600 |
| 7 Specialist salary | K-12 | 13,500 |
| 8 Cost per special student-related equipment | K-12 | 0 |
| 9 Number of special equipment units per student | K-12 | 0 |
| 10 Cost per normal student-related equipment | K-12 | 0 |

SOURCE: No. 6, BPM; No. 7, PPB District; No. 8, No. 9, and No. 10, Assumed.

Table 11

CATEGORY 3: TWO-DIMENSIONAL INPUTS

No. 11: Textbook and Material Cost per Student

| | Grade | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Subject* | *K* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
| 1 Reading | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 0 | 0 | 0 | 0 |
| 2 English | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 6.75 | 6.75 | 6.75 | 6.75 |
| 3 Mathematics | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 2.95 | 2.95 | 2.95 | 2.95 |
| 4 Social Science | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 3.60 | 3.60 | 3.60 | 3.60 |
| 5 Science | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 5.45 | 5.45 | 5.45 | 5.45 |
| 6 Fine Arts | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 6.60 | 6.60 | 6.60 | 6.60 |
| 7 Health | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 0 | 0 | 0 | 0 |
| 8 Physical Education | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 8.50 | 8.50 | 8.50 | 8.50 |
| 9 Foreign Language | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.10 | 3.10 | 3.10 | 3.10 |
| 10 Industrial Arts | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.70 | 6.70 | 6.70 | 6.70 |
| 11 Driver Education | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.30 | 2.30 |
| 12 Agriculture | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.70 | 6.70 | 6.70 | 6.70 |
| 13 Distributive Education | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.70 | 6.70 | 6.70 | 6.70 |
| 14 Office | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.85 | 2.85 | 2.85 | 2.85 |
| 15 Homemaking | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5.30 | 5.30 | 5.30 | 5.30 |
| 16 Trade and Industrial | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.70 | 6.70 | 6.70 | 6.70 |
| 17 Other, 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 Other, 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 Other, 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 Other, 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

SOURCE: Grades K-8, BPM; Grades 9-12, PPB District.

Table 12

CATEGORY 3: TWO-DIMENSIONAL INPUTS

No. 12 through No. 15

| *Description* | *Grade* | *All Subjects* |
|---|---|---|
| 12 Instruction-related maintenance factor | K-12 | 0 |
| 13 Instruction-related transportation | K-12 | 0 |
| 14 Lifetime of student-related special equipment | K-12 | 0 |
| 15 Miscellaneous cost factor | K-12 | 0 |

SOURCE: Assumed.

Table 13

CATEGORY 4: THREE-DIMENSIONAL INPUTS

| | | *No. 2 High School Students* | | |
|---|---|---|---|---|
| *Grade* | *No. 1 Elementary Students* | *Vocational (1)* | *General Educ (2)* | *College Prep (3)* |
| K | 1760 | | | |
| 1 | 1740 | | | |
| 2 | 1740 | | | |
| 3 | 1720 | | | |
| 4 | 1720 | | | |
| 5 | 1700 | | | |
| 6 | 1700 | | | |
| 7 | 1680 | | | |
| 8 | 1680 | | | |
| 9 | | 550 | 550 | 550 |
| 10 | | 540 | 540 | 540 |
| 11 | | 530 | 530 | 530 |
| 12 | | 520 | 520 | 520 |

SOURCE: Assumed.

Table 14

CATEGORY 4: THREE-DIMENSIONAL INPUTS

No. 3: Elementary School Probability Factors

| *Subject* | *Grade* K | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| Reading | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| English | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Mathematics | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Social Science | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Science | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Fine Arts | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Health | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Physical Education | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

SOURCE: Assumed.

Table 15

CATEGORY 4: THREE-DIMENSIONAL INPUTS

No. 4: High School Probability Factors

| *Subject* | *Grade* | *Vocational (1)* | *General Educ (2)* | *College Prep (3)* |
|---|---|---|---|---|
| 1 Reading | 9 | 0 | 0 | 0 |
| | 10 | 0 | 0 | 0 |
| | 11 | 0 | 0 | 0 |
| | 12 | 0 | 0 | 0 |
| 2 English | 9 | 1.0 | 1.1 | 1.1 |
| | 10 | 1.0 | 1.0 | 1.3 |
| | 11 | 1.0 | 1.1 | 1.2 |
| | 12 | .4 | .9 | 1.0 |
| 3 Mathematics | 9 | .2 | .3 | .5 |
| | 10 | .1 | .5 | .7 |
| | 11 | 0 | .5 | .5 |
| | 12 | 0 | .2 | .5 |
| 4 Social Science | 9 | 2.0 | 2.1 | 2.1 |
| | 10 | 1.0 | 1.0 | 1.0 |
| | 11 | 1.0 | 1.0 | 1.0 |
| | 12 | 1.0 | 1.2 | 1.7 |
| 5 Science | 9 | .1 | .3 | .4 |
| | 10 | .1 | .5 | .7 |
| | 11 | 0 | .5 | .5 |
| | 12 | 0 | .2 | .5 |
| 6 Fine Arts | 9 | .2 | .2 | .2 |
| | 10 | .1 | .2 | .4 |
| | 11 | 0 | .2 | .4 |
| | 12 | 0 | .4 | .2 |
| 7 Health | 9 | 0 | 0 | 0 |
| | 10 | 0 | 0 | 0 |
| | 11 | 0 | 0 | 0 |
| | 12 | 0 | 0 | 0 |
| 8 Physical Education | 9 | 1.0 | 1.0 | 1.0 |
| | 10 | 1.0 | 1.0 | 1.0 |
| | 11 | 1.0 | 1.0 | 1.0 |
| | 12 | 1.0 | 1.0 | 1.0 |
| 9 Foreign Language | 9 | 0 | .1 | .4 |
| | 10 | 0 | .1 | .4 |
| | 11 | 0 | .1 | .4 |
| | 12 | 0 | 0 | .2 |
| 10 Industrial Arts | 9 | .3 | .1 | 0 |
| | 10 | .4 | .2 | 0 |
| | 11 | .4 | .2 | .1 |
| | 12 | .5 | .2 | .1 |
| 11 Driver Education | 9 | 0 | 0 | 0 |
| | 10 | 0 | 0 | 0 |
| | 11 | .3 | .3 | .3 |
| | 12 | .3 | .3 | .3 |

Table 15--continued

| Subject | Grade | Vocational (1) | General Educ (2) | College Prep (3) |
|---|---|---|---|---|
| 12 Agriculture | 9 | .2 | 0 | 0 |
| | 10 | .1 | 0 | 0 |
| | 11 | .1 | 0 | 0 |
| | 12 | .1 | 0 | 0 |
| 13 Distributive Education | 9 | 0 | 0 | 0 |
| | 10 | 0 | 0 | 0 |
| | 11 | 0 | 0 | 0 |
| | 12 | 0 | 0 | 0 |
| 14 Office | 9 | .2 | .1 | .1 |
| | 10 | .6 | .2 | 0 |
| | 11 | .6 | .2 | .1 |
| | 12 | .8 | .3 | .1 |
| 15 Homemaking | 9 | .2 | .1 | .05 |
| | 10 | .6 | .2 | 0 |
| | 11 | .6 | .2 | .1 |
| | 12 | .8 | .2 | .1 |
| 16 Trade and Industrial | 9 | .1 | 0 | 0 |
| | 10 | .4 | 0 | 0 |
| | 11 | .4 | 0 | 0 |
| | 12 | .5 | 0 | 0 |
| 17 Other, 1 | 9 | 0 | 0 | 0 |
| | 10 | 0 | 0 | 0 |
| | 11 | 0 | 0 | 0 |
| | 12 | 0 | 0 | 0 |
| 18 Other, 2 | 9 | 0 | 0 | 0 |
| | 10 | 0 | 0 | 0 |
| | 11 | 0 | 0 | 0 |
| | 12 | 0 | 0 | 0 |
| 19 Other, 3 | 9 | 0 | 0 | 0 |
| | 10 | 0 | 0 | 0 |
| | 11 | 0 | 0 | 0 |
| | 12 | 0 | 0 | 0 |
| 20 Other, 4 | 9 | 0 | 0 | 0 |
| | 10 | 0 | 0 | 0 |
| | 11 | 0 | 0 | 0 |
| | 12 | 0 | 0 | 0 |

SOURCE: Assumed.

Table 16

CATEGORY 4: THREE-DIMENSIONAL INPUTS

No. 5: Inventory Equipment Package for Student-Related Equipment

| *Course and Grade* | *All Subjects* |
|---|---|
| Vocational (1) 9-12 | 0 |
| General Educ (2) 9-12 | 0 |
| College Prep (3) 9-12 | 0 |

SOURCE: Assumed.

Table 17

CATEGORY 4: THREE-DIMENSIONAL INPUTS

No. 6: Class Hours per Week

| *Subject* | | *K* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Class* | | | | | | | | | | | | |
| 1 Reading | Lec | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 English | Lec | 2 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 Mathematics | Lec | 2 | 3 | 3 | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 Social Science | Lec | 1.5 | 3 | 3 | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 Science | Lec | 1.5 | 3 | 3 | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 3 | 3 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 2 |
| 6 Fine Arts | Lec | 2 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 1 | 1 | 1 | 1 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 4 | 4 |
| 7 Health | Lec | 1 | 1.5 | 1.5 | 1.5 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 Physical Education | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| | Lab | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 |
| 9 Foreign Language | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 5 | 5 | 5 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 Industrial Arts | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 5 | 5 | 5 |
| 11 Driver Education | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .5 | .5 |
| 12 Agriculture | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 4 | 4 |
| 13 Distributive Education | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 4 | 4 |
| 14 Office | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 2 | 1 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 3 | 4 |
| 15 Homemaking | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 3 | 3 |
| 16 Trade and Industrial | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 5 | 5 | 5 |
| 17 Other, 1 | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 Other, 2 | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 Other, 3 | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 Other, 4 | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

SOURCE: Assumed.

Table 18

CATEGORY 4: THREE-DIMENSIONAL INPUTS

No. 7: Ratio of Teacher-Hours per Class-Hour[a]

| Subject | | K | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Class* | | | | | | | | | | | | |
| 1 Reading | Lec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 English | Lec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 Mathematics | Lec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 Social Science | Lec | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 Science | Lec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 6 Fine Arts | Lec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 7 Health | Lec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 Physical Education | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| | Lab | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 9 Foreign Language | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 Industrial Arts | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 11 Driver Education | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 12 Agriculture | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 13 Distributive Education | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 14 Office | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 15 Homemaking | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 16 Trade and Industrial | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 17 Other, 1 | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 Other, 2 | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 Other, 3 | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 Other, 4 | Lec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

SOURCE: Assumed

[a]Based on a 1 to 1 ratio.

Table 19

CATEGORY 4: THREE-DIMENSIONAL INPUTS

No. 8: Paraprofessional Hours per Classroom Hour

| *Subject* | | *Class* K-8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|
| 1 Reading | Lec | .05 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 |
| 2 English | Lec | 0 | .05 | .05 | .05 | .05 |
| | Lab | 0 | 0 | 0 | 0 | 0 |
| 3 Mathematics | Lec | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 |
| 4 Social Science | Lec | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 |
| 5 Science | Lec | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 |
| 6 Fine Arts | Lec | .15 | 0 | 0 | 0 | 0 |
| | Lab | 0 | .15 | .15 | .15 | .15 |
| 7 Health | Lec | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 |
| 8 Physical Education | Lec | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 |
| 9 Foreign Language | Lec | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 |
| 10 Industrial Arts | Lec | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 |
| 11 Driver Education | Lec | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 |
| 12 Agriculture | Lec | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 |
| 13 Distributive Education | Lec | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 |
| 14 Office | Lec | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 |
| 15 Homemaking | Lec | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 |
| 16 Trade and Industrial | Lec | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 |
| 17 Other, 1 | Lec | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 |
| 18 Other, 2 | Lec | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 |
| 19 Other, 3 | Lec | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 |
| 20 Other, 4 | Lec | 0 | 0 | 0 | 0 | 0 |
| | Lab | 0 | 0 | 0 | 0 | 0 |

SOURCE: PPB District.

Table 20

CATEGORY 4: THREE-DIMENSIONAL INPUTS

No. 9 through No. 11

| | *Description* | *All Subjects and Grades* |
|---|---|---|
| 9 | Material cost per classroom | 0 |
| 10 | Special equipment cost per classroom | 0 |
| 11 | Lifetime of special classroom-related equipment | 0 |

SOURCE: Assumed

Table 21

CATEGORY 5: FOUR-DIMENSIONAL INPUTS

| *Description* | *All Subjects and Grades* |
|---|---|
| No. 1, Special equipment package inventory for classroom-related equipment | 0 |

SOURCE: Assumed.